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A study of water self-diffusion in model biological membranes, oriented lipid bilayers

Rudakova M., Gimatdinov R., Filippov A.
Kazan Federal University, 420008, Kremlevskaya 18, Kazan, Russia

Abstract

Water self-diffusion in a multibilayer structure formed by dipalmitoylphosphatidylcholine and oriented on glass plates was studied by pulsed field gradient nuclear magnetic resonance technique. Water molecules were shown to be in several states differing in the extent of interaction with lipid molecules. A spectrum of water self-diffusion coefficients in the direction transverse to the bilayers was found. The use of samples with different distances between plates, the analysis of the dependence of the shape of the diffusion decay of spin echo signal on diffusion time and sample orientation, and the measurements at temperatures above and below the gel-to-liquid crystalline phase transition point (also in samples containing cholesterol) allowed the separation of the component of the diffusion decay responsible for the transbilayer migration of water. The use of the Tanner model provided a possibility to estimate the permeability coefficient of the bilayers. The formation of mechanical defects (cracks) in the flat oriented bilayers was shown to be the most probable reason for the presence of a water component with a relatively high diffusion coefficient.

Keywords

Biomembranes, Defects of structure, NMR, Permeability, Self-diffusion